APPENDIX 1. PROPULSION SYSTEM RELIABILITY ASSESSMENT

1. ASSESSMENT PROCESS. In order to establish if a particular airframe-engine combination has satisfied the current propulsion system reliability requirements for extended range operations, thorough assessment will be conducted by a group of FAA specialists, the Propulsion System Reliability Assessment Board (PSRAB) utilizing all the pertinent propulsion system data and information available (includes the APU, if required). Engineering and operational judgment supported by the relevant statistics will be used to determine current propulsion system reliability. The findings of the specialist group will be included in the FAA Airplane Assessment Report.

a. Service Experience. To provide a reasonable indication of airplne propulsion system reliability trends and to reveal problem areas, a certain amount of service experience will be required. In general, extended range airframe-engine combination reliability assessments concern two major categories; those supporting up to 120 minutes maximum diversion time operations and those support operations beyond 120 minutes maximum diversion times. A special case-by-case operational approval may be granted for 75-minute diversion routes and require limited evaluation of service experience at the time of the application.

(1) Operations up to 120 Minutes. Normally, accumulation of at least 250,000 engine hours in the world fleet will be necessary before the assessment process can produce meaningful results. This number of hours may be reduced if adequate compensating factors are identified which give a reasonable equivalent data base as established by the PSRAB. Where experience on another airplane is applicable to a candidate airplane, a significant portion of the 250,000 hours experience should normally be obtained by the candidate airplane. In the event that a particular engine is derived from an existing engine, the required operational experience is subject to establishing the degree of hardware commonality and operating similarities.

(2) Operations beyond 120 Minutes (180 minutes). Suitability to operate the airplane beyond 120 minutes will not be considered until operational experience in 120 minute extended range service clearly indicates further credit is appropriate. This would generally include at least one year of service experience with an ETOP configured fleet at 120-minute operation with a corresponding high level of demonstrated propulsion system reliability.

(3) 75-Minute Operation Authorization. In this category, service experience of the airframe-engine combination may be less than the 250,000 hours as provided in subparagraph a(1). It must be shown that sufficient favorable experience has been accumulated, demonstrating a level of reliability appropriate for

75-minute extended range operation. As detailed earlier in the Advisory Circular, a particular operator may receive a special 75-minute authorization following review on a case-by-case basis by the Director, Flight Standards Service.

b. Reliability Data Base. To adequately assess propulsion system reliability, consideration of the proposed maximum diversion time, for extended range type design approval, certain world-fleet data and information are required. The PSRAB intends to maximize the use of existing sources and kinds of data generally available; however, additional data may be required in certain cases. In support of applications for extended range type design approval, data should be provided from various sources to ensure completeness; i.e., engine manufacturer, operator, and airplane manufacturer. Data so provided should include all event descriptions, qualifications, and any pertinent details necessary to help determine the impact on propulsion system reliability. These data should include:

(1) A list of all engine shutdown events both ground and in flight for all causes (excluding normal training events) including flameout. The list should provide identification (engine and airplane model and serial number), engine configuration and modification history, engine position, circumstances leading up to the event, phase of flight or ground operation, weather/environmental conditions, and reason for shutdown. In addition, similar information should be provided for all occurrences where control or desired thrust level was not attained.

(2) Unscheduled engine removal rate (accumulated 6 and 12 months), removal summary, time history of removal rate and primary causes for unscheduled engine removal.

(3) Dispatch delays, cancellations, aborted takeoffs (includes those induced by maintenance or crew error) and en route diversions chargeable to the propulsion system.

(4) Total engine hours and cycles and engine hour population (age distribution).

(5) Mean time between failure of propulsion system components that affect reliability.

(6) IFSD rate based on a 6- and 12-month rolling average.

(7) Additional data as specified by the PSRAB.

c. Risk Management and the Risk Model. In order to assure that the risks of increased diversion times are acceptable, a risk model has been constructed. The risk model is based upon the known service records of an established large fleet of twin-engine civil transport-turbo fan powered airplane. The service experience of this "<u>base fleet</u>" has been very satisfactory and reflective of a high level of safety in its propulsion systems. It has achieved an average in-flight shutdown rate of approximately .02/1000 hours for a 10-year period while flying predominately on routes conforming to the requirements of FAR Section 121.161 (i.e., flight paths within 60 minutes flying time from a adequate airport).

(1) The risk of engine failure during a single-engine diversion event is directly related to the diversion flight time and the propulsion system reliability or IFSD rate. This assumes the failure of the first engine, which causes the diversion, is unrelated to the probability of failure of the second engine during the diversion. Common cause or related failure modes will be discussed in Paragraph 1(d). The product of IFSD rate and diversion time can be designated as a risk factor for the diversion and identified as (λT). For the base fleet of .02/1000 IFSD rate and 60 minutes maximum diversion, (λT) would be (.02/1000)(60). Identifying this base fleet risk factor as (λT)*, other combinations of IFSD rates and diversion times can be ratioed to this base risk factor to determine ETOP relative risk, **(λT)/(λT)*.** For ETOP diversion times of 60 minutes and IFSD rates of .02/1000, the relative risk factor equals 1.0. This relationship is shown in Figure 1.

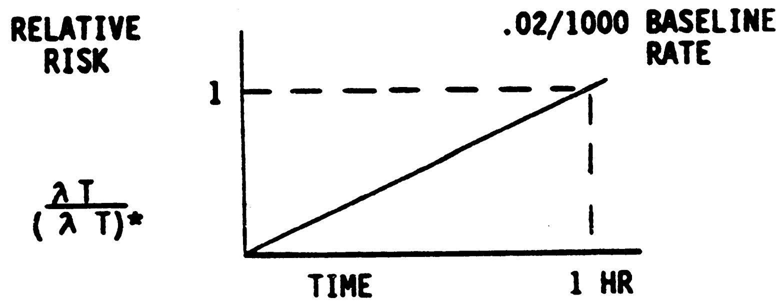

FIGURE 1

(2) Extending this model to a family of IFSD rates and diversion times, Figure 2 depicts the relationship between diversion time, IFSD rate, and risk relative to the base fleet during the diversion:

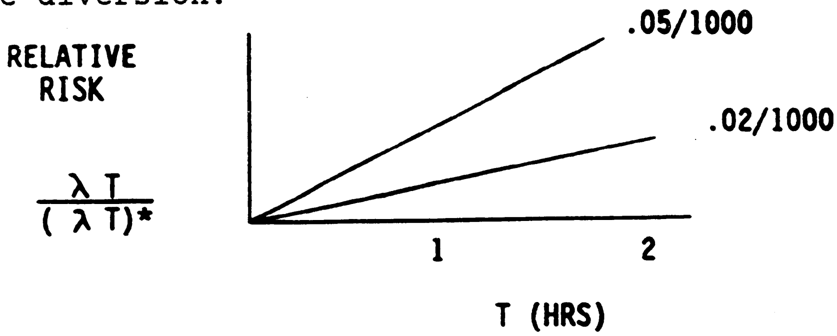

FIGURE 2

2. RELIABILITY LEVELS. As discussed in Paragraph 1, in order to ensure that risks associated with increased diversion times are acceptable, reliabilities of ETOP propulsion systems must be shown to approach or equal those of the highly reliable base fleet of .02/1000 and the appropriate operational and maintenance requirements implemented (see Figure 3).

a. Operations up to 120 Minutes. The overall fleet reliability should approach or achieve that of the highly reliable base fleet following incorporation of the appropriate configuration maintenance and operational requirements. Propulsion system maturity rates have suggested that incorporation of propulsion system improvements following review of 250,000 hours service experience have yielded an approximate .03/1000 improvement in IFSD reliability. Given the IFSD objective of approximately .02/1000 hours and the potential improvement rate of .03/1000 hours, the extended range operation start threshold can be established at approximately .05/1000 hours (see Figure 3). It should be noted that this is threshold and specific circumstances in fleet reliability data such as confidence in problem resolution, types of failures, etc., could be relevant in establishing a start threshold other than .05/1000.

b. Operations Beyond 120 Minutes. The overall fleet reliability should achieve that of the highly reliable base fleet prior to approval. Only those airframe-engine combinations exhibiting the highest levels of overall reliability will be found satisfactory for this type of operation (see Figure 3). In addition, it will normally be a necessary prerequisite for these airplanes to have at least one year of satisfactory ETOP service involving 120 minutes or less operation under conditions of this AC.

c. Reliability Targets-Summary. Utilizing the risk model, it can be shown that when progressing from the entry level required reliability to the target level reliability (achieved for 180 minutes), the overall risk is not adversely impacted considering respective increases in diversion time. (See Figure 3.)

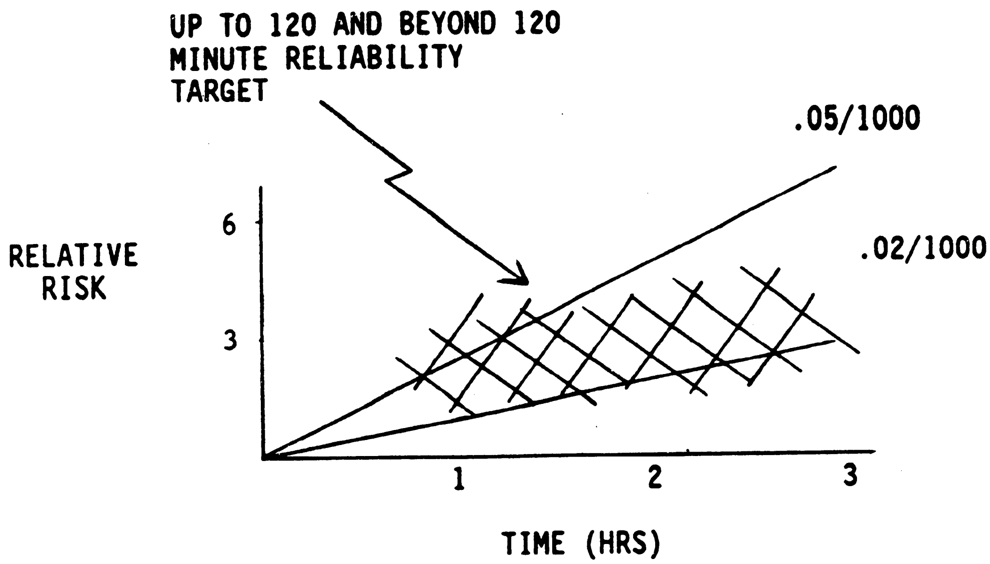

FIGURE 3

d. Risk Model Corroboration with Analysis. As a check of the conservatism for reliability levels identified by the risk model, an analysis can be performed which, given certain assumptions, can corroborate the model targets and identify areas of importance where on-going design, operation, and maintenance vigilance must be continued. In the construction of such an analysis, it is assumed that the probability of total thrust loss on any given twin engine airplane flight is made up of those engine failure mechanisms which are independent events (e.g., left engine failure independent from right engine failure) and these engine failure events which are related to a common source (e.g., left and right engines fail as a result of a common or related event). This may be shown as:

$$P_{TT} = P_{TI} + P_{TC} \qquad (1)$$

P_{TT} = Total probability of complete thrust loss on any given flight.

P_{TI} = Probability of complete thrust loss on flight due to independent causes.

P_{TC} = Probability of complete thrust loss on flight due to common causes.

In determination of the probability of total thrust loss due to independent causes (P_{TI}), International Civil Aviation Organization Report No. AN-WP/5593 titled "Extended Range Operation of Twin-Engine Commercial Air Transport Aeroplanes," dated February 15, 1984, contains an analytical assessment of in-flight shutdown rate, flight time, and diversion time as equated to an observed assessment of commercial transport aircraft accidents worldwide for a recent several year period. This relationship, as derived in this study, is shown as:

$$\text{IFSD Rate} \quad \sqrt{\frac{10^{-8}\,(.6 + .4T)}{TY}} \qquad (2)$$

Where: T = intended duration of flight
Y = diversion time

As an example, for a flight of seven hours and a diversion time of two hours, equation (2) identifies an IFSD of .05/1000 as necessary, while for a diversion time of three hours, .04/1000 is necessary to provide a level of probability supporting the reference world accident rate. As can be seen, the risk model identified in paragraph 1.c. of this Appendix requires an achieved IFSD rate of one half that calculated using the ICAO assessment. It is believed essential that the ETOPS IFSD rate provided by paragraph 1.c. of this Appendix be required considering the influence of common cause failure mechanisms (P_{TC}) as well as the uncertainties associated with assumption identified in the ICAO study.

Although there has been no suitable analytical models developed for assessment of the probability of complete thrust loss in flight due to common cause events (P_{TC}), it is considered that by establishment of highly reliable propulsion systems through achievement of low in-flight shutdown rates, continual engine and airplane design monitoring for those potential common mode service difficulties, and vigilant maintenance and operational practices as identified in Appendices 4 and 5, risks associated with total thrust loss can be maintained at acceptable low levels (Figure 4).

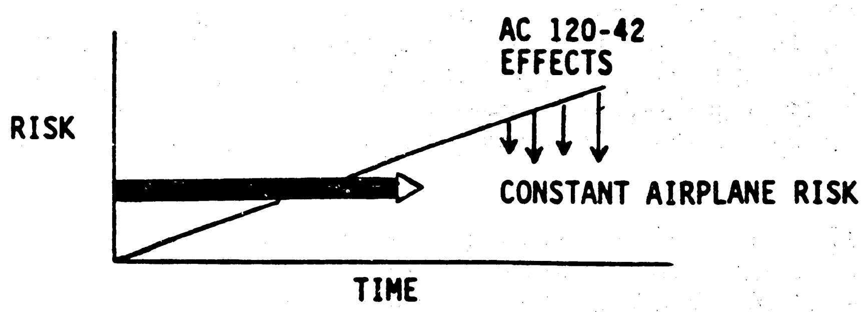

FIGURE 4

e. Propulsion System Approval Considerations. The determination that a propulsion system is suitable per the assessment considerations of either of the two major categories is provided by the PSRAB. Table 1 identifies the constituent elements of the two major categories of approval considerations.

Table 1.

Propulsion System Approval Considerations

Up to 120 Minute Operation	Greater Than 120 Minute Operation
o 250,000 engine hours (significant portion with experience candidate airplane).	o same plus at least additional one year with the approved extended range configured fleet.
o achieve an IFSD of approximately .05/1000 (the objective is continuing improvement towards a rate of .02/1000 hours).	o achieve and maintain an IFSD of approximately .02/1000 hours.
o Periodic review of propulsion system data and service experience, and revise the CMP standard as appropriate.	o same - schedule for incorporation of CMP standards requirements, may be shorter.

3. ENGINEERING ASSESSMENT. The methodology to be used by the FAA in determining adequate propulsion system reliability will be a problem-oriented approach using fail-safe concepts, an assessment of the maturation of the propulsion system, the achieved level of IFSD rate, engineering and operational judgment and reliability analysis, and will consist of:

a. An analysis, on a case-by-case basis, of all significant failures, defects and malfunctions experienced in service (or during testing) for the airframe-engine combination being addressed. Significant failures are principally those causing or resulting in in-flight shutdown or flameout of the engine(s), but may also include unusual ground failures, uncommanded thrust reduction, and/or unscheduled removal of engines from the airplane. In making the assessment, consideration will be given to the following:

(1) The type of engine, previous experience, similarity in hardware and operating characteristics with other engines, and the engine operating rating limit to be used with one-engine shutdown.

(2) The trends in cumulative and 6- and 12-month rolling average, updated quarterly, of in-flight shutdown rates versus propulsion system flight hours and cycles.

(3) The effect of corrective modifications, maintenance, etc., on the possible future reliability of the propulsion system.

(4) Maintenance actions recommended and performed and their effect on engine and APU failure rates.

(5) The accumulation of operational experience which covers the range of environmental limitations likely to be encountered.

(6) Intended maximum flight duration and approved maximum diversion time.

b. An assessment of the corrective actions taken for each problem identified with the objective of verifying that the action is sufficient to correct the deficiency.

c. When each identified significant deficiency has a corresponding FAA-approved corrective action and when all corrective actions are satisfactorily incorporated and verified, the PSRAB determines that an acceptable level of reliability can be achieved. Statistical corroboration will also be utilized. When foreign manufacturer's and/or operator's data are being evaluated, the respective civil airworthiness authorities will be offered the opportunity to participate. They will be briefed by the PSRAB during the proceedings and provided a copy of the final report for their review.

4. <u>PSRAB FINDINGS</u>. Once an assessment has been completed and the PSRAB has documented its findings, the FAA will declare whether or not the particular airframe-engine combination satisfies the relevant considerations of this AC. Items recommended to qualify the propulsion system, maintenance requirements, and limitations will be included in the Airplane Assessment Report (Paragraph 8.e.).

5. <u>ON-GOING FLEET MONITORING</u>. In order to ensure that the desired level of reliability is maintained, the PSRAB will continuously monitor reliability data and periodically review its original findings. In addition the FAA document containing the CMP standard will be revised as necessary.

APPENDIX 2. THE FAA FAIL-SAFE DESIGN CONCEPT

1. FAA FAIL-SAFE DESIGN CONCEPT. The FAR Part 25 airworthiness standards are based on, and incorporate, the objectives, and principles or techniques, of the fail-safe design concept, which considers the effects of failures and combinations of failures in defining a safe design. The following basic objectives pertaining to failures apply:

a. In any system or subsystem, the failure of any single element, component, or connection during any one flight (brake release through ground deceleration to stop) should be assumed, regardless of its probability. Such single failures should not prevent continued safe flight and landing, or significantly reduce the capability of the airplane or the ability of the crew to cope with the resulting failure conditions.

b. Subsequent failures during the same flight, whether detected or latent, and combinations thereof, should also be assumed, unless their joint probability with the first failure is shown to be extremely improbable.

2. FAIL-SAFE PRINCIPLES AND/OR TECHNIQUES. The fail-safe design concept uses the following design principles or techniques in order to ensure a safe design. The use of only one of these principles or techniques is seldom adequate. A combination of two or more is usually needed to provide a fail-safe design; i.e., to ensure that major failure conditions are improbable and that catastrophic failure conditions are extremely improbable.

a. Designed Integrity and Quality. Including Life Limits, to ensure intended function and prevent failures.

b. Redundancy or Backup Systems to enable continued function after any single (or other number of) failure(s); e.g., two or more hydraulic systems, flight control systems, etc.

c. Isolation of Systems, Components, and Elements so that the failure of one does not cause the failure of another. Isolation is also termed independence.

d. Proven Reliability so that multiple, independent failures are unlikely to occur during the same flight.

e. Failure Warning or Indication to provide detection.

f. Flightcrew Procedures for use after failure detection, to enable continued safe flight and landing by specifying crew corrective action.

g. Checkability: the capability to check a component's condition.

h. Designed Failure Effect Limits, including the capability to sustain damage, to limit the safety impact or effects of a failure.

i. Designed Failure Path to control and direct the effects of a failure in a way that limits its safety impact.

j. Margins or Factors of Safety to allow for any undefined or unforeseeable adverse conditions.

k. Error-Tolerance that considers adverse effects of foreseeable errors during the airplane's design, test, manufacture, operation, and maintenance.

APPENDIX 3. SUITABLE EN ROUTE ALTERNATE AIRPORTS

1. GENERAL.

a. One of the distinguishing features of two-engine extended range operations is the concept of a suitable en route alternate airport being available to which an airplane can divert after a single failure or failure combinations which require a diversion. Whereas most two-engine airplanes operate in an environment where there is usually a choice of diversion airports available, the extended range airplane may have only one alternate within a range dictated by the endurance of a particular airframe system (e.g., cargo fire suppressant), or by the approved maximum diversion time for that route.

b. It is, therefore, important that any airport designated as an en route alternate has the capabilities, services, and facilities to safely support that particular airplane, and that the weather conditions at the time of arrival provide a high assurance that adequate visual references are available upon arrival at decision height (DH) or minimum descent altitude (MDA), and that the surface wind conditions and corresponding runway surface conditions are within acceptable limits to permit the approach and landing to be safely completed with an engine and/or systems inoperative.

2. ADEQUATE AIRPORT. As with all other operations, an operator desiring any route approval should show that it is able to satisfactorily conduct scheduled operations between each required airport other than that route or route segment. Operators should show that the facilities and services specified in FAR Section 121.97 through 121.107 for domestic and flag air carriers (FAR Sections 121.113 through 121.127 for supplemental air carriers and commercial operators) are available and adequate for the proposed operation. For the purpose of this advisory circular, in addition to meeting Part 121 requirements of the FAR, those airports which meet the provisions of Part 139 and those foreign airports which are determined to be equivalent to the provisions of subparts D and E of FAR Part 139 for that particular airplane are considered to be adequate airports.

3. SUITABLE AIRPORT. For an airport to be suitable for the purpose of this advisory circular, it should have the capabilities, services, and facilities necessary to designate it as an adequate airport, and have weather and field conditions at the time of the particular operation which provide a high assurance that an approach and landing can be safely completed with an engine and/or systems inoperative in the event that a diversion to the en route alternate becomes necessary. Due to the natural variability of weather conditions with time as well as the

need to determine the suitability of a particular en route airport prior to departure, the en route alternate weather minima for dispatch purposes are generally higher than the weather minima necessary to initiate an instrument approach. This is necessary to assure that the instrument approach can be conducted safely if the flight has to divert to the alternate airport. Additionally, since the visual reference necessary to safely complete an approach and landing is determined, among other things, by the accuracy with which the airplane can be controlled along the approach path by reference to instruments and the accuracy of the ground-based instrument aids, as well as the tasks the pilot is required to accomplish to maneuver the airplane so as to complete the landing, the weather minima for nonprecision approaches are generally higher than for precision approaches.

4. STANDARD EN ROUTE ALTERNATE AIRPORT WEATHER MINIMA. The following are established for flight planning and dispatch purposes with two-engine airplanes in extended range operations. These weather minima recognize the benefits of precision approaches, as well as the increased assurance of safely completing an instrument approach at airports which are equipped with precision approaches to at least two separate runways, (two separate landing surfaces). A particular airport may be considered to be a suitable airport for flight planning and dispatch purposes for extended range operations if it meets the criteria of Paragraph 3 of this Appendix and has one of the following combinations of instrument approach capabilities and en route alternate airport weather minima:

a. A Single Precision Approach:

Ceiling of 600 feet and a visibility of 2 statute miles or a ceiling of 400 feet and a visibility of 1 statute mile above the lowest authorized landing minima; whichever is higher.

b. Two or More Separate Precision Approach Equipped Runways:

Ceiling of 400 feet and a visibility of 1 statute miles or a ceiling of 200 feet and a visibility of 1/2 statute mile above the lowest authorized landing minima; whichever is higher.

c. Non-precision approach(es):

Ceiling of 800 feet and a visibility of 2 statute miles or a ceiling of 400 feet and a visibility of 1 statute mile above the lowest authorized landing minima; whichever is higher.

5. LOWER THAN STANDARD EN ROUTE ALTERNATE AIRPORT WEATHER MINIMA. Lower than standard en route alternate airport weather minima may be considered for approval for certain operators on a case-by-case basis by the Director, Flight Standards Service, at suitably equipped airports for certain airplanes which have the certificated capability to safely conduct Category II and/or Category III approach and landing operations after encountering any failure

condition in the airframe and/or propulsion systems which would result in a diversion to an en route alternate airport. Subsequent failures during the diversion, which would result in the loss of the capability to safely conduct and complete Category II and/or Category III approach and landing operations, should be shown to be improbable. The certificated capability of the airplane should be evaluated considering the approved maximum diversion time. Lower than standard en route alternate weather minima may be considered at suitably equipped airports, if appropriate, for those airplanes which have these approved capabilities considering the established maximum diversion time.

6. EN ROUTE ALTERNATE SUITABILITY IN FLIGHT. The suitability of an en route alternate airport for an airplane which encounters a situation inflight which necessitates a diversion, including the provisions of FAR Section 121.565, while en route on an extended range operation is based on a determination that the airport is still suitable for the circumstances, and the weather and field conditions at that airport will permit an instrument approach to be initiated and a landing completed.

APPENDIX 4. 75, 120, and 180 MIN. ETOPS MAINTENANCE REQUIREMENTS

1. GENERAL. The maintenance program for airplanes used in 75-, 120-, and 180-minute ETOPS should contain the standards, guidance, and direction necessary to support the intended operations. Maintenance personnel involved in affecting this program should be made aware of the special nature of ETOPS and have the knowledge, skills and ability to accomplish the requirements of the program.

a. ETOPS Maintenance Program.

(1) Airplane Suitability. The airframe-engine combination being submitted for ETOPS consideration will be reviewed by the FAA, Propulsion System Reliability Assessment Board (PSRAB) and the responsible type certificate holding office. The FAA will review data accrued by the world fleet and the operator from operation of ETOPS candidate airplanes to help establish the operator's capability to conduct ETOPS operations. This candidate airplane should meet the requirements of Paragraph 9 of this advisory circular. The FAA will review data on the airframe-engine combination and identify any conditions that exist which could prevent safe operation.

NOTE: The candidate airplane for a 75-minute diversion time is not required to have achieved a predetermined number of hours or in-flight shutdown rate for this assessment.

(2) Maintenance Program. The basic maintenance program for the airplane being considered for ETOPS is the continuous airworthiness maintenance program currently approved for that operator, for the make and model airframe-engine combination. This program should be reviewed by the PMI to ensure that it provides an adequate basis for development of a supplemental ETOPS maintenance program. ETOPS maintenance requirements will be expressed in, and approved as, supplemental requirements. This should include maintenance procedures to preclude identical action being applied to multiple similar elements in any ETOP critical system (e.g., fuel control change on both engines). This relates to common cause concerns identified in Appendix 1, Paragraph 2.(d).

(i) ETOPS related tasks should be identified on the operator's routine work forms and related instructions.

(ii) ETOPS related procedures, such as involvement of centralized maintenance control, should be clearly defined in the operators program.

(iii) An ETOPS service check should be developed to verify that the status of the airplane and certain critical items are acceptable. This check should be accomplished and signed off by an ETOPS qualified maintenance person immediately prior to an ETOPS flight.

NOTE: The service check may not be required for the return leg of a 75-minute ETOPS flight in a benign area of operation (defined in Appendix 5).

(iv) Log books should be reviewed and documented as appropriate to ensure proper MEL procedures, deferred items, maintenance checks and that system verification procedures have been properly performed.

(3) ETOPS Manual. The operator should develop a manual for use by personnel involved in ETOPS. This manual need not be inclusive but should at least reference the maintenance programs and other requirements described by this advisory circular, and clearly indicate where they are located in the operator's manual system. All ETOPS requirements, including supportive programs, procedures, duties, and responsibilities, should be identified and subject to revision control. This manual should be submitted to the certificate-holding office 60 days before implementation of ETOPS flights.

(4) Oil Consumption Program. The operator's oil consumption program should reflect the manufacturer's recommendations and be sensitive to oil consumption trends. It should consider the amount of oil added at the departing ETOPS stations with reference to the running average consumption; i.e., the monitoring must be continuous up to, and including, oil added at the ETOPS departure station. If oil analysis is meaningful to this make and model, it should be included in the program. If the APU is required for ETOPS operation, it should be added to the oil consumption program.

(5) Engine Condition Monitoring. This program should describe the parameters to be monitored, method of data collection and corrective action process. The program should reflect manufacturer's instructions and industry practice. This monitoring will be used to detect deterioration at an early stage to allow for corrective action before safe operation is effected. The program should ensure that engine limit margins are maintained so that a prolonged single-engine diversion may be conducted without exceeding approved engine limits (i.e., rotor speeds, exhaust gas temperatures) at all approved power levels and expected environmental conditions. Engine margins preserved through this program should account for the effects of additional engine loading demands (e.g., anti-ice, electrical, etc.) which may be required during the single-engine flight phase associated with the diversion. (See Paragraph 8b(2)(iv).)

(6) Resolution of Airplane Discrepancies. The operator should develop a verification program or procedures should be established to ensure corrective action following an engine shutdown, primary system failure, adverse trends or any prescribed events which require verification flight or other action and establish means to assure their accomplishment. A clear description of who must initiate verification actions and the section or group responsible for the determination of what action is necessary should be identified in the program. Primary systems, like APU, or conditions requiring verification actions should be described in the operators ETOPS maintenance manual.

(7) Reliability Program. An ETOPS reliability program should be developed or the existing reliability program supplemented. This program should be designed with early identification and prevention of ETOPS related problems as the primary goal. The program should be event-orientated and incorporate reporting procedures for significant events detrimental to ETOPS flights. This information should be readily available for use by the operator and FAA to help establish that the reliability level is adequate, and to assess the operator's competence and capability to safely continue ETOPS. The FAA certificate-holding district office should be notified within 72 hours of events reportable through this program.

(i) Besides the items required to be reported by Section 21.3 and 121.703 of the FARs, the following items should also be included:

(A) In-flight shutdowns.

(B) Diversion or turnback.

(C) Uncommanded power changes or surges.

(D) Inability to control the engine or obtain desired power.

(E) Problems with systems critical to ETOPS.

(F) Any other event detrimental to ETOPS.

(ii) The report should identify the following.

(A) Airplane identification (type and N-Number).

(B) Engine identification (make and serial number).

(C) Total time, cycles, and time since last shop visit.

(D) For systems, time since overhaul or last inspection of the discrepant unit.

(E) Phase of flight.

(F) Corrective action.

(8) Propulsion System Monitoring. Firm criteria should be established as to what action is to be taken when adverse trends in propulsion system conditions are detected. When the propulsion system IFSD (computed on a 12-month rolling average) exceeds .05/1000 engine hours for a 120-minute operation, or exceeds .03/1000 engine hours for a 180-minute operation, an immediate evaluation should be accomplished by the operator and certificate-holding district office with consultation of the PSRAB. A report of problems identified and corrective actions taken will be forwarded to the Director, Flight Standards Service. With advice of the PSRAB, additional corrective action or operational restriction may be recommended.

(9) Maintenance Training. The maintenance training program should focus on the special nature of ETOPS. This program should be included in the normal maintenance training program. The goal of this program is to ensure that all personnel involved in ETOPS are provided the necessary training so that the ETOPS programs are properly accomplished and to emphasize the special nature of ETOPS maintenance requirements. Qualified maintenance personnel are those that have completed the operator's extended range training program and have satisfactorily performed extended range tasks under the direct supervision of a FAA certificated maintenance person; who has had previous experience with maintaining the particular make and model aircraft being utilized under the operator's maintenance program.

(10) ETOPS Parts Control. The operator should develop a parts control program that ensures the proper parts and configuration are maintained for ETOPS. The program includes verification that parts placed on ETOPS airplanes during parts borrowing or pooling arrangements, as well as those parts used after repair or overhaul, maintain the necessary ETOPS configuration for that airplane.

APPENDIX 5. ETOPS OPERATIONAL PROGRAM CRITERIA

1. GENERAL. Paragraphs 10.a. through 10.h. of this AC detail the criteria for operational approval of extended range operations with a maximum diversion time of 120 minutes to an en route alternate (at approved single-engine inoperative cruise speed). This appendix serves the function of differentiating the criteria for approval of operations less than 120 minutes (75 minutes) and beyond 120 minutes (180 minutes). For approval of 75-minute operations, not all of the requirements of the basic AC need necessarily be met. For approval of 180 minute operations, all of the requirements of the basic AC must be met along with the requirements identified in the Appendix as necessary for 180-minute operations.

2. 75-MINUTE OPERATION. Deviations to Section 121.161 of the FAR were granted to conduct 75-minute ETOPS in the Western Atlantic Caribbean Sea in 1977. Due to the benign nature of the area of operation, the criteria for type design, maintenance, and operational programs were less stringent than that contained in AC 120-42. Experience has shown that operations have been conducted safely and successfully since that time. In 1987, deviation to FAR Section 121.161 was granted to conduct 75-minute ETOPS in the North Atlantic. Due to more demanding area of operations, maintenance and operational programs which met the criteria of AC 120-42 were applied. The Type Design ETOP approval criteria were not required; however, the airframe-engine combination was reviewed prior to approval. Operations have been conducted successfully. The criteria detailed below are the basis for evaluating different areas of operation and requirement for approving 75-minute operation.

a. Benign Area of Operation. To be defined as a benign area of operation, the following considerations should apply:

(1) Numerous adequate airports.

(2) A high level of reliability and availability are required of communications, navigation, and ATC services and facilities.

(3) Prevailing weather conditions are stable and generally do not approach extremes in temperature, wind, ceiling, and visibility.

b. Criteria for Deviation to Operate in a Benign Area of Operation.

(1) Type Design. The airframe-engine combination should be reviewed to determine if there are any factors which would effect safe conduct of operations. Type design ETOP approval criteria are not necessarily required.

(2) Maintenance programs should follow the guidance in Appendix 4 for 75-minute programs.

(3) Operational Programs.

(i) Minimum Equipment List. Provision of the FAA MMEL, excluding "Extended Range" provisos, apply.

(ii) Dispatch limitations. Flight should be operated at a weight that permits the flight, at approved one-engine inoperative cruise speed and power setting, to maintain flight altitude at or above the Minimum En route Altitude.

c. Demanding Area of Operation. A demanding area of operations for the purpose of 75-minute approval has one or more of the following characteristics:

(1) Weather. Prevailing weather conditions can approach extremes in winds, temperature, ceiling, and visibility for protracted periods of time.

(2) Alternates. Adequate airports are not numerous.

(3) Due to remote or overwater area, a high level of reliability and availability of communications, navigation, and ATC facilities services may not exist.

d. Criteria for Deviation to Operate in a Demanding Area of Operation.

(1) Type Design. The airframe-engine combination should be reviewed to determine any factors which could effect safe operations in the demanding area of operations. Type design ETOP approval criteria are not necessarily required.

(2) Maintenance programs should be instituted which follow the guidance in Appendix 4 for 120-minute operation.

(3) Operation programs should be instituted which follow the guidance contained in this AC for 120-minute programs.

3. 180-MINUTE OPERATION. Each operator requesting approval to conduct extended range operations beyond 120 minutes should have approximately 12 consecutive months of operational inservice experience with the specified ETOPs configured airframe-engine combination in the conduct of 120-minute operations. The substitution of inservice experience which is equivalent to the actual conduct of 120 operators will be established by the Director, Flight Standards Service, on a case-by-case basis. Prior to approval, the operator's capability to conduct operations and implement effective ETOP programs in accordance with the criteria detailed in Paragraph 10 of this advisory circular will be

examined. Only operators who have demonstrated capability to conduct a 120-minute program successfully will be considered for approval beyond 120 minutes. These operators should also demonstrate additional capabilities discussed in this paragraph. Approval will be given on a case-by-case basis for an increase to their area of operation beyond 120 minutes. The area of operation will be defined by a maximum diversion time of 180 minutes to an adequate airport at approved one-engine inoperative cruise speed (under standard conditions in still air). The dispatch limitation will be a maximum diversion time of 180 minutes to a suitable airport at approved single-engine inoperative speed (under standard conditions in still air).

a. Dispatch Considerations.

(1) MEL. The MEL should reflect adequate levels of primary system redundancy to support 180-minute (still air) operations. The systems listed in Paragraph 10.d.(2)(i) through (xv) should be considered.

(2) Weather. An operator should substantiate that the weather information system which it utilizes can be relied upon to forecast terminal and en route weather with a reasonable degree of accuracy and reliability in the proposed area of operation. Such factors as staffing, dispatcher training, sources of weather reports and forecasts, and when possible, a record of forecast reliability should be evaluated.

(3) Fuel. The critical fuel scenario should also consider fuel required for all engine operations at 10,000 feet or above 10,000 feet if the airplane is equipped with sufficient supplemental oxygen in accordance with FAR Section 121.329.

(4) Operational Control Practices and Procedures. During the course of the flight, the flightcrew should be informed of any significant changes in conditions at designated en route alternates. Prior to a 180-minute ETOP flight proceeding beyond the extended range entry point, the forecast weather for the time periods established in paragraph 10.d(5)(iii), landing distances, and airport services and facilities at designated en route alternates should be evaluated. If any conditions are identified (such as weather forecast below landing minima) which would preclude safe approach and landing, the pilot should be notified and an acceptable alternate(s) selected where safe approach and landing can be made. The maximum diversion time to the newly selected alternate(s) should not exceed 180 minutes at the approved single-engine inoperative cruise speeds (under standard conditions in still air).

(5) Flight Planning. Operators should provide for compliance with FAR Section 121.565. The effects of wind and temperature at single-engine inoperative cruise altitude should be accounted for. In addition, the operator's program should provide

flightcrews with information on suitable airports appropriate to the route to be flown which are not forecast to meet Appendix 3 en route alternate weather minima. Airport facility information, and other appropriate planning data concerning these airports should be provided to flightcrews for use in complying with FAR Section 121.565 when executing a diversion.

b. Crew Training and Evaluation.

(1) If standby sources of electrical power significantly degrade cockpit instrumentation to the pilots, then approved training which simulates approach with the standby generator as the sole power source should be conducted during initial and recurrent training.

(2) Contingency Procedures. Flightcrews should be provided detailed initial and recurrent training which emphasizes established contingency procedures for each area of operation intended to be used.

(3) Diversion Decisionmaking. Special initial and recurrent training to prepare flightcrews to evaluate probable propulsion and airframe systems failures should be conducted. The goal of this training should be to establish crew competency in dealing with the most probable operating contingencies.

c. Equipment.

(1) VHF/Satellite Data Link. Operators should consider enhancements to their operational control system as soon as they become feasible.

(2) Automated System Monitoring. Automated airplane system status monitoring should be provided to enhance the flightcrew's ability to make timely diversion decisions.

4. VALIDATION FLIGHT OR FLIGHTS. The operator should demonstrate by means of an FAA witnessed validation flight that it has the capability to safely conduct 180-minute operations with the specified airframe-engine combination. The guidance for validation flights contained in Paragraph 10.h. of this AC should be followed.

U.S. Department
of Transportation

**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

RETURN POSTAGE GUARANTEED

Official Business
Penalty for Private Use $300